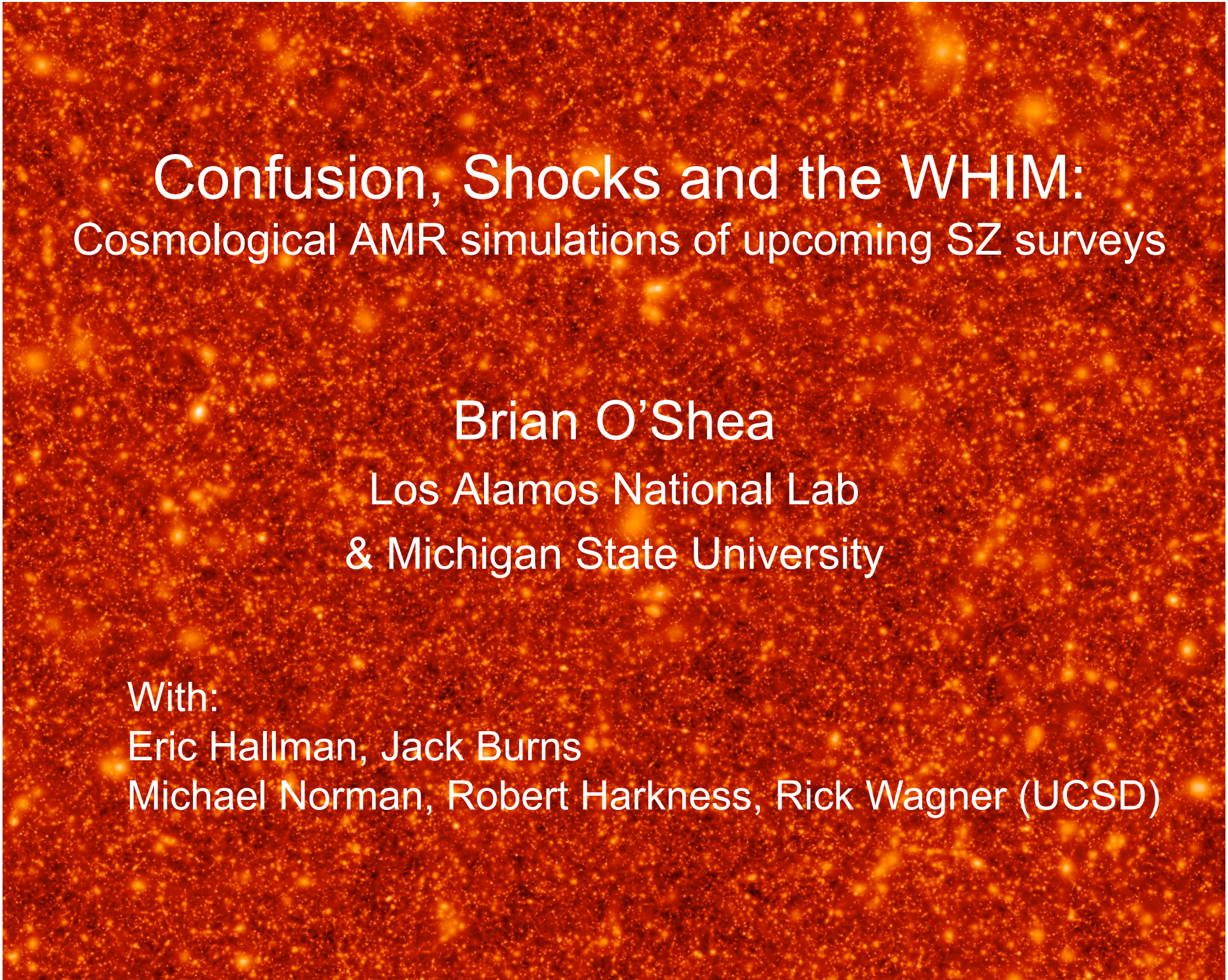


Confusion, Shocks and the WHIM:
Cosmological AMR simulations of upcoming SZ surveys

Brian O'Shea

Los Alamos National Lab

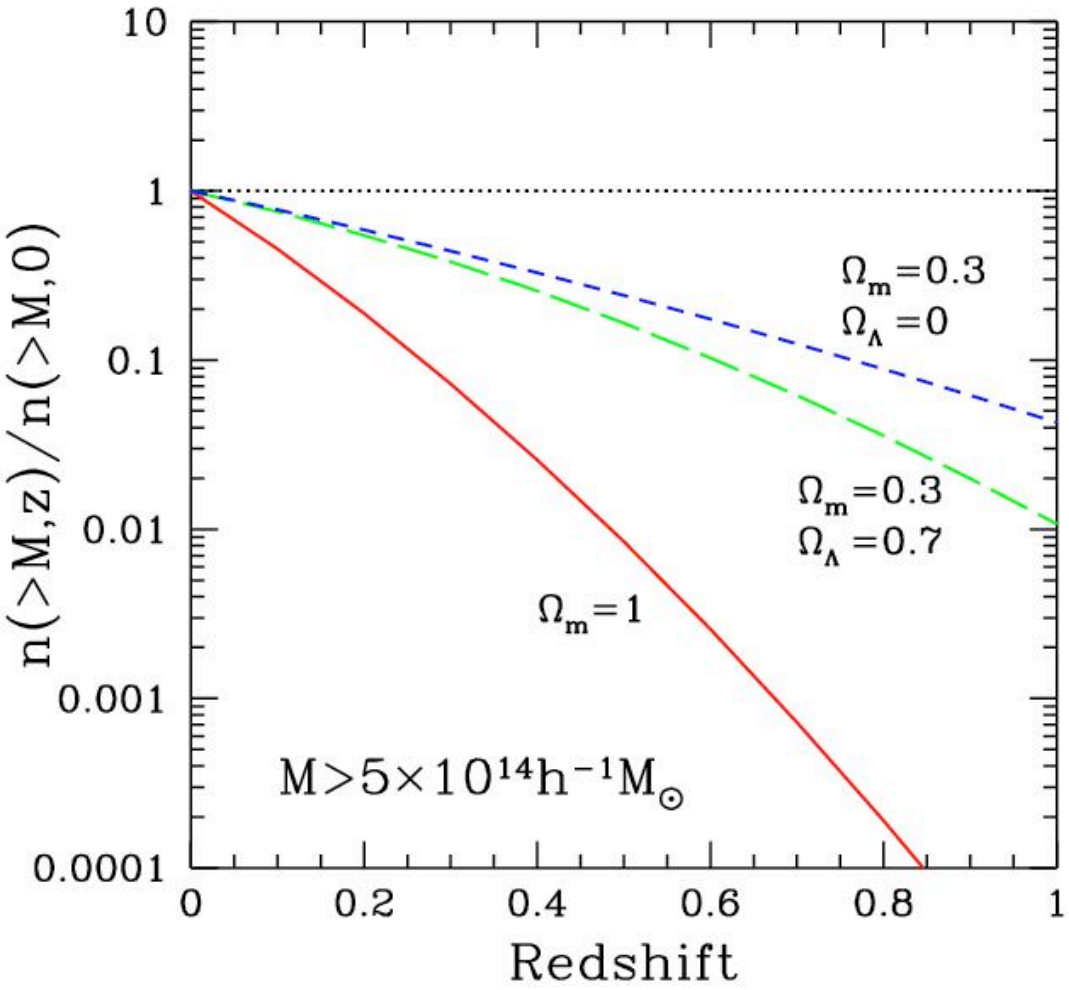
& Michigan State University

With:

Eric Hallman, Jack Burns

Michael Norman, Robert Harkness, Rick Wagner (UCSD)

Constraints from clusters



Borgani, 2003

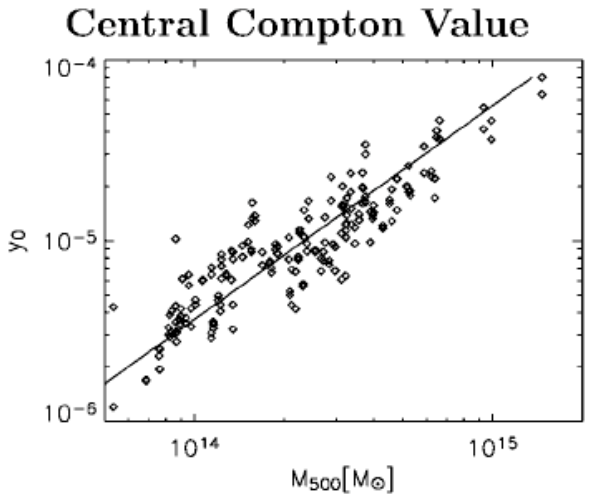
Current & Upcoming SZE surveys

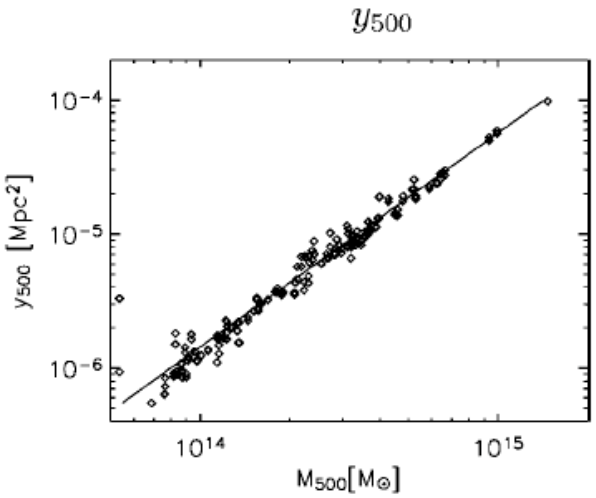
CHARACTERISTICS OF UPCOMING SZE SURVEYS

Survey	Angular Coverage	Beam Size (~144 GHz) (arcmin)	rms Sensitivity per beam (μK)
APEX-SZ	TBD	1.0	10
SPT	4000 deg^2	1.0	10
ACT	100 deg^2	1.7	2
Planck	All-sky	7.1	6.0

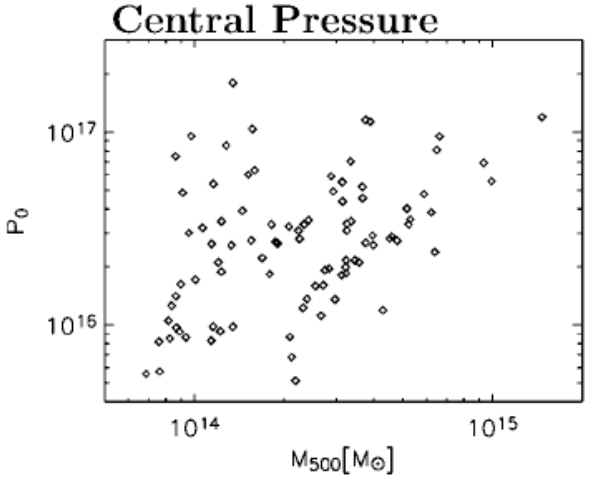
R_{vir} ~ several arcmin @ z ~ 0.5

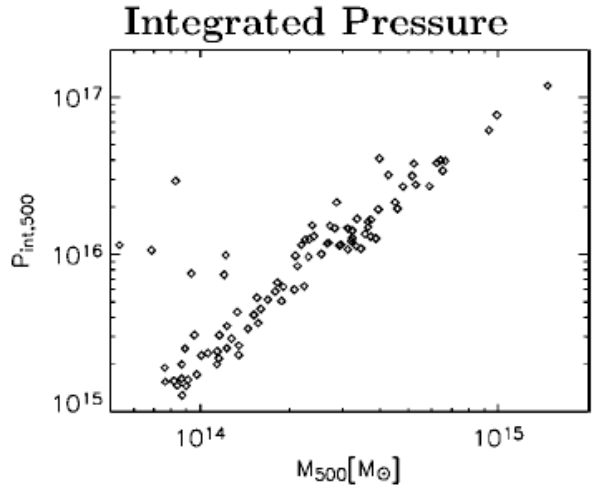
Integrated cluster observables better measure of mass





(no surprise here)





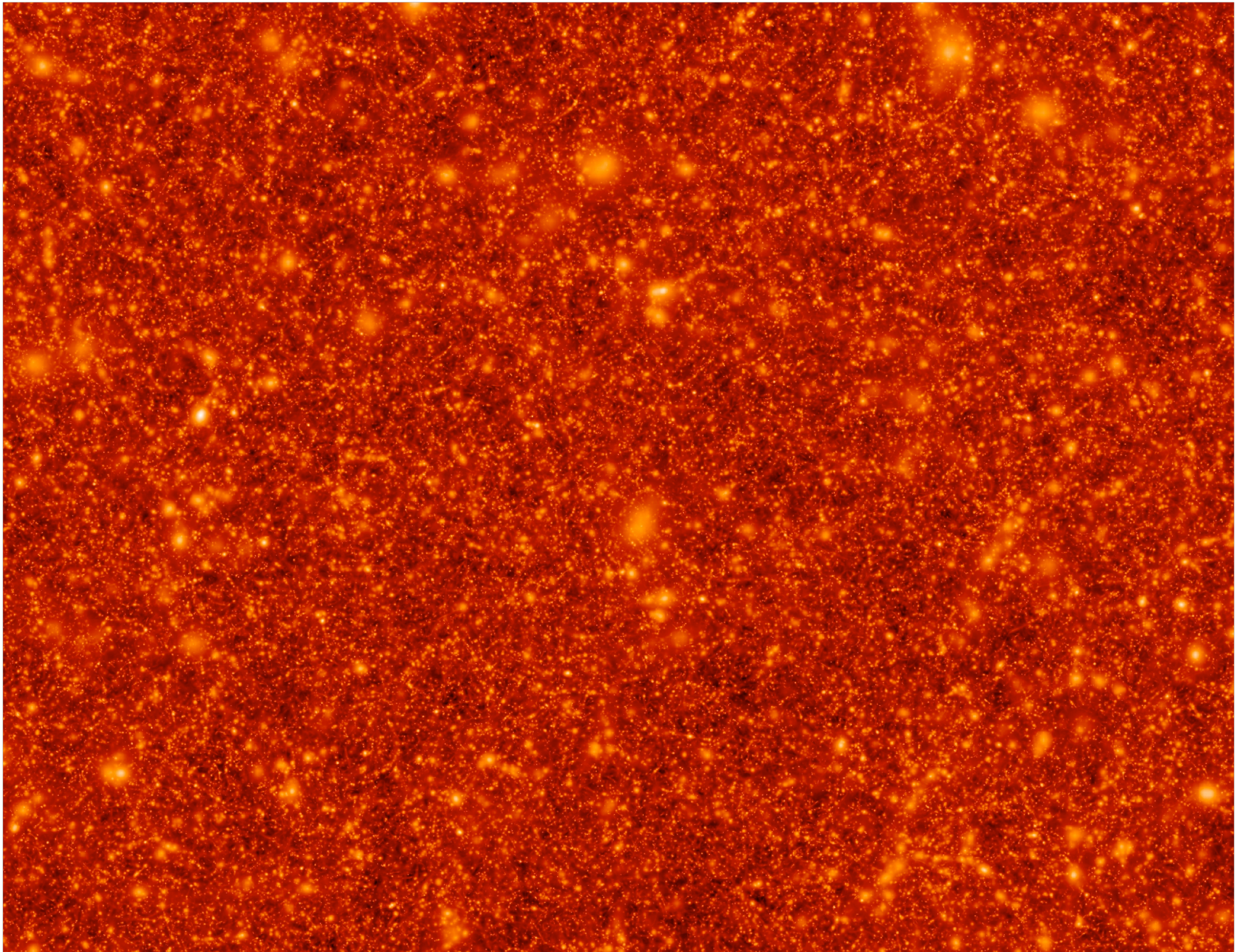
Motl et al. 2005

Why hydrodynamical simulations?

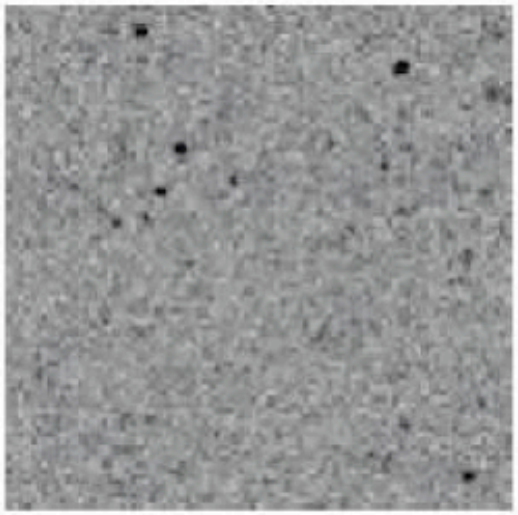
- N-body only sims make many assumptions (clusters spherical, in hydrostatic equilibrium, “neat”)
- Real universe is messy: clusters highly elongated, not in equilibrium, merging, etc.
- Also, intervening material (WHIM/filaments) may play an important role

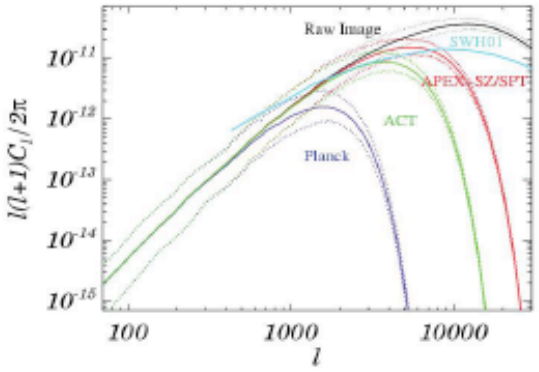
Constructing a light cone

- Start with Enzo simulations: 512 Mpc/h, 512^3 root grid, 7 levels of AMR (8 kpc resolution), N-body + hydro
- Output simulation at appropriate intervals (dz ~ 0.5 box width)
- Rotate, shift, stack images (shift+rotate to avoid stacking same clusters on top of each other) to make 10x10 degree light cone
- Degrade images to appropriate resolution, add noise, instrumental effects, etc.



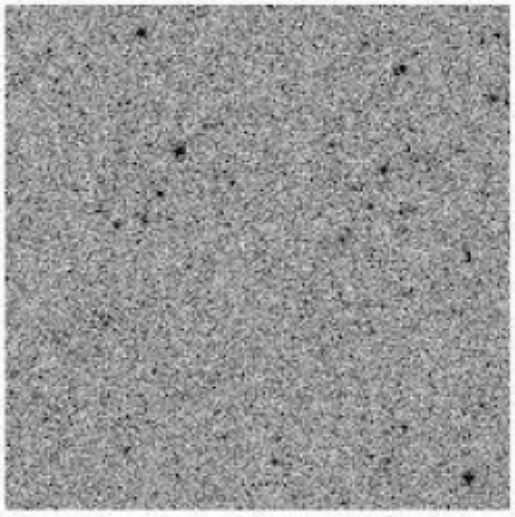
Planck
(7.1', 6 muK
@ 144 Ghz)

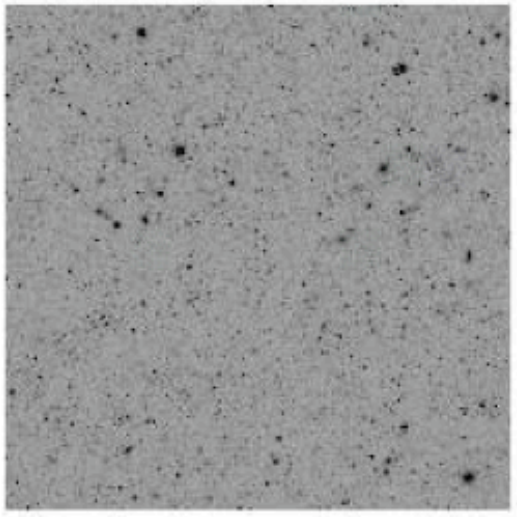




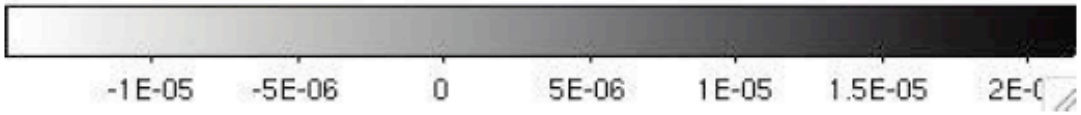
Angular
power
spectrum

APEX/SPT
(1.0', 10 muK
@ 144 Ghz)

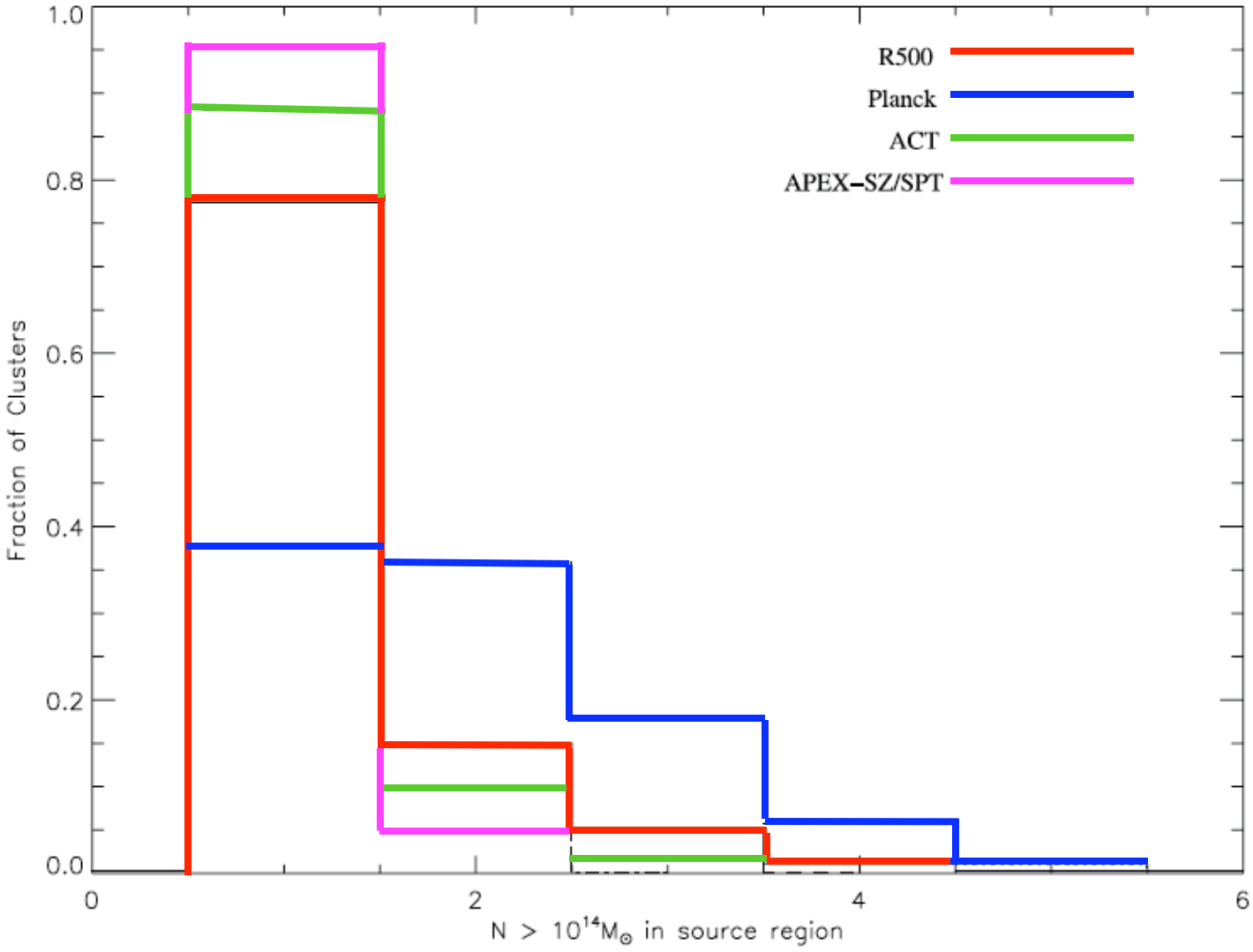




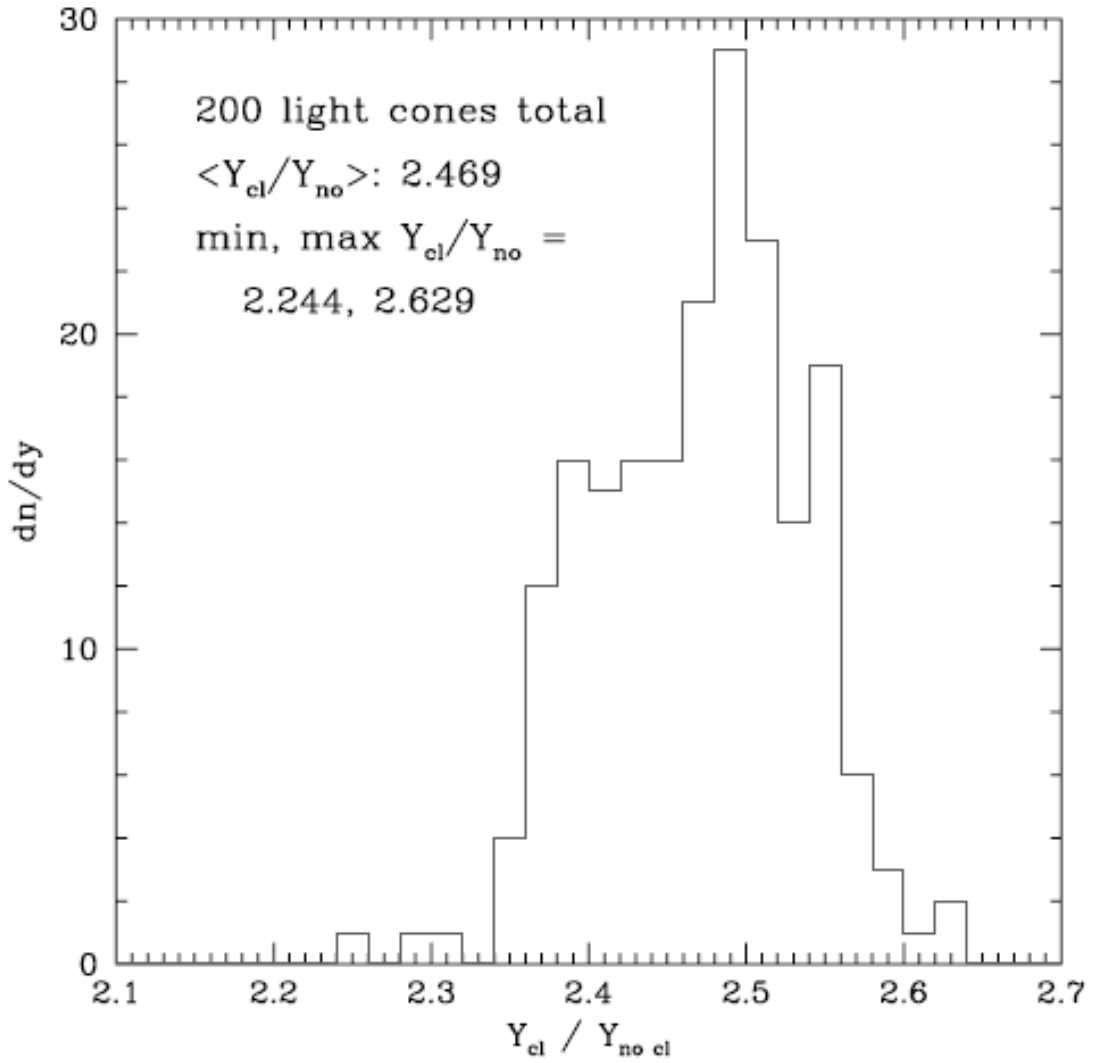
ACT
(1.7', 2 muK
@ 144 Ghz)



Confusion from overlapping clusters



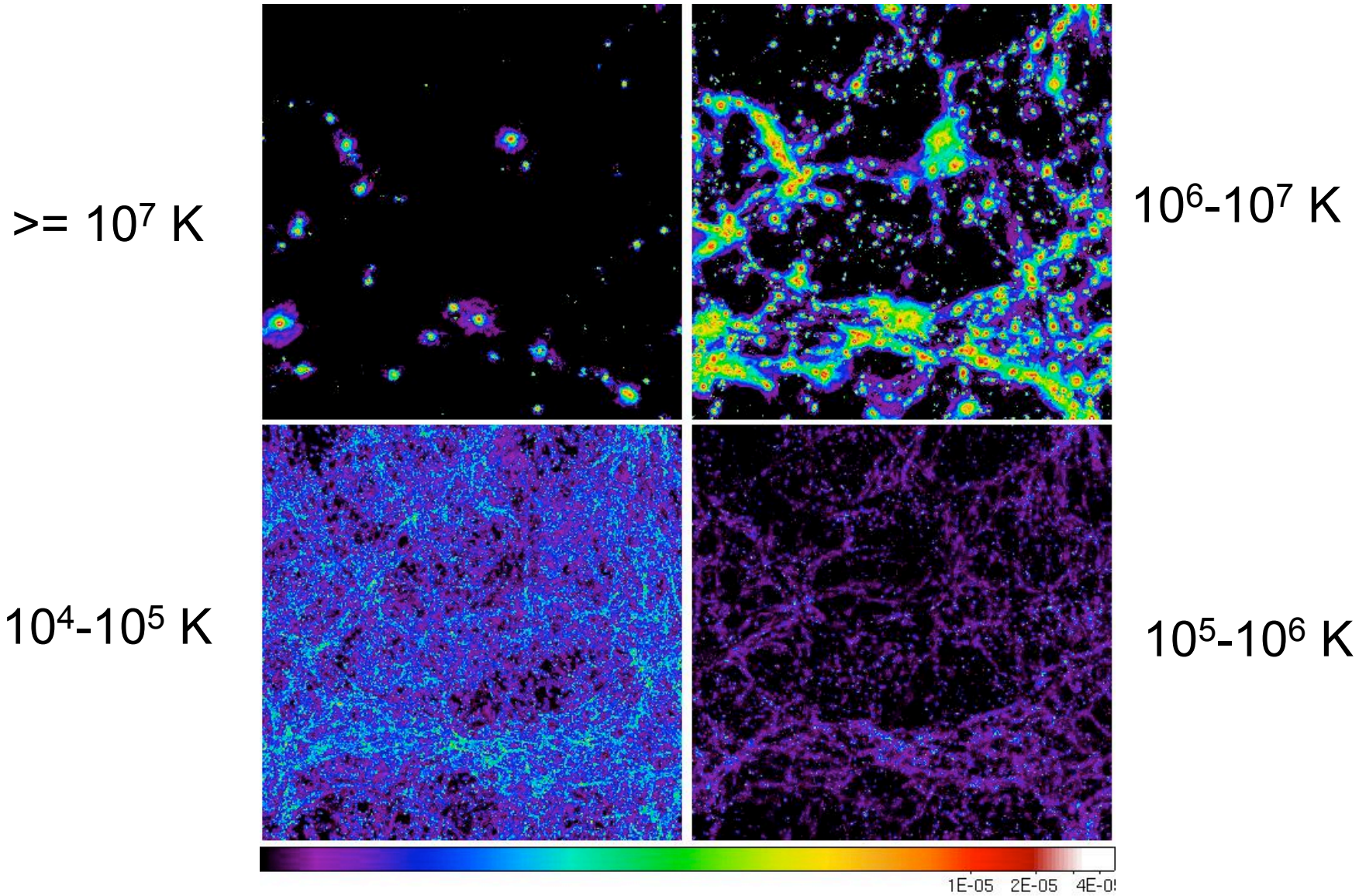
Non-cluster contribution to integrated SZ flux



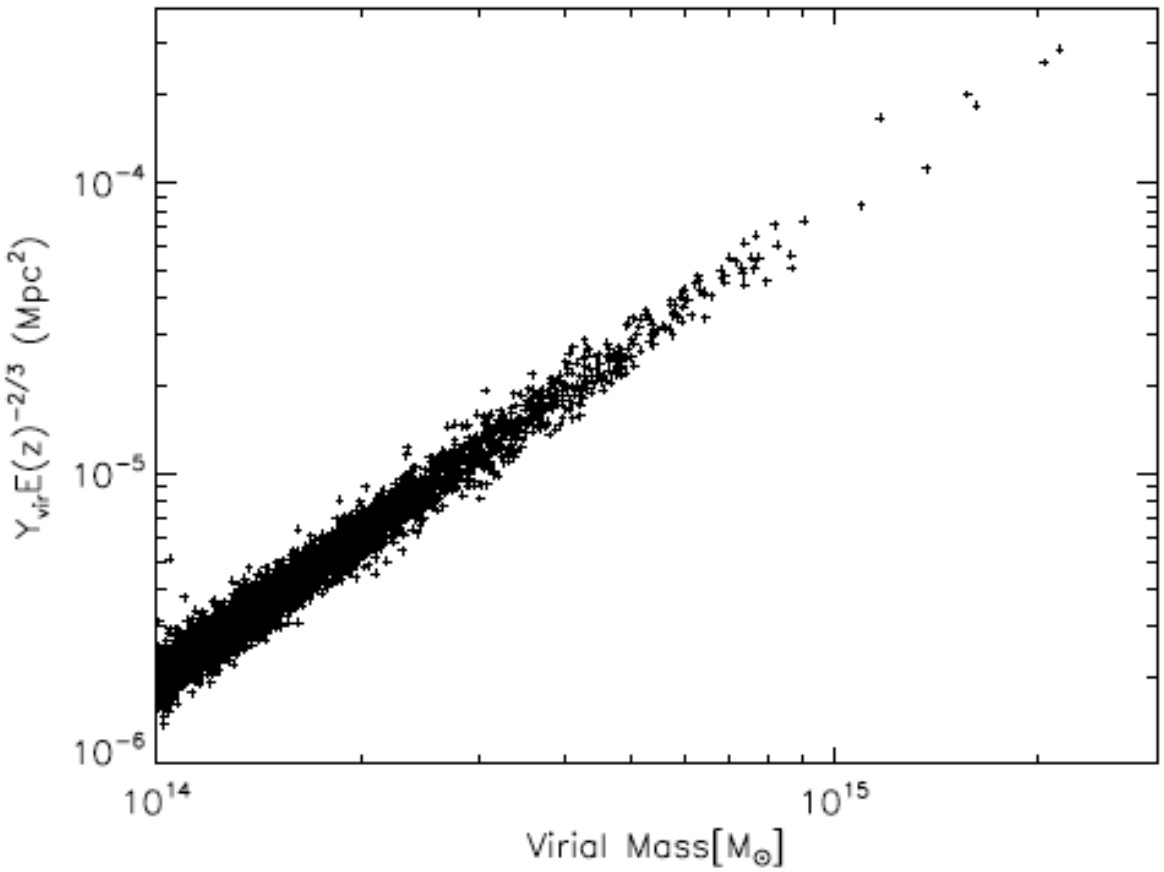
"no cl" = Flux left over after all halos >5e13 Msun removed

Note: much greater contribution when halos below obs'n cutoff threshold counted (~50%)

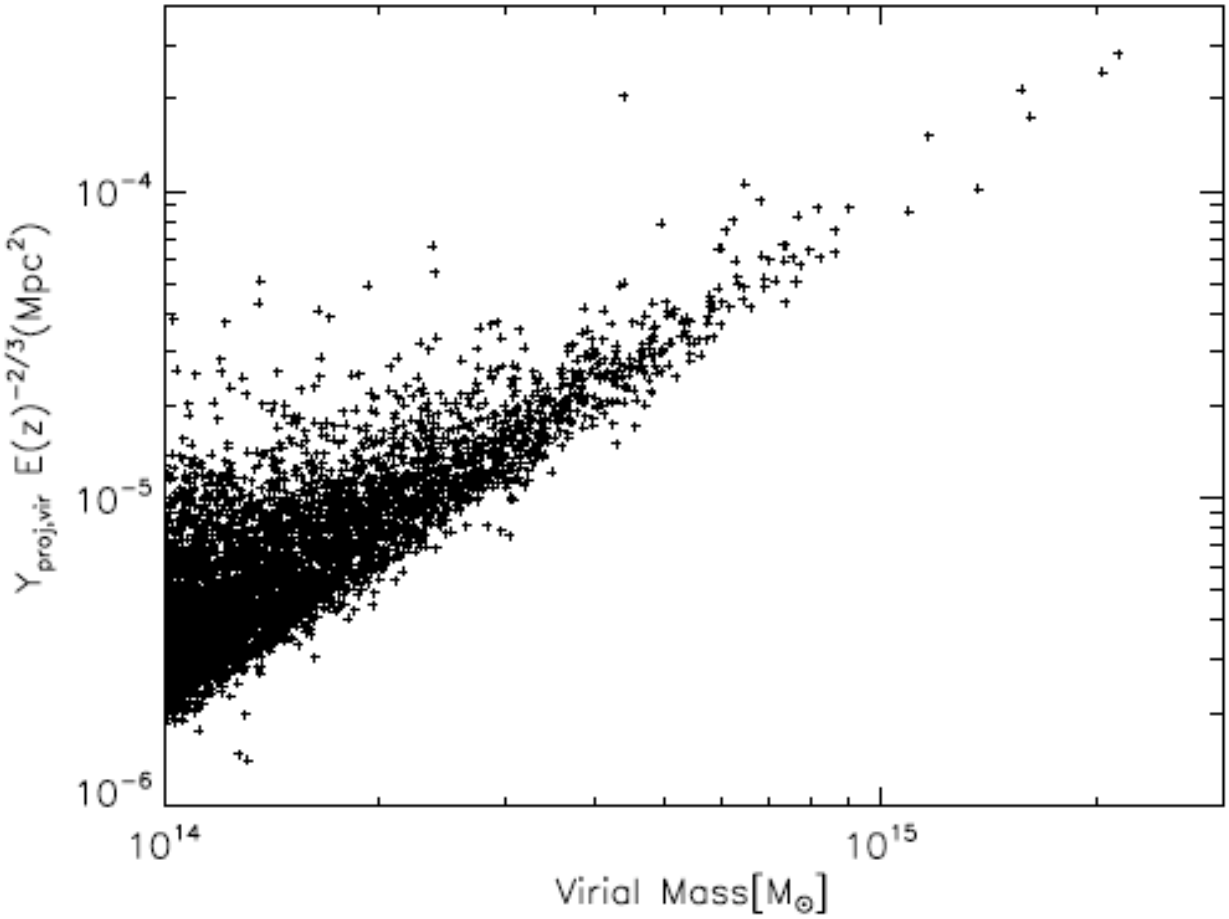
Flux contribution by gas temperature



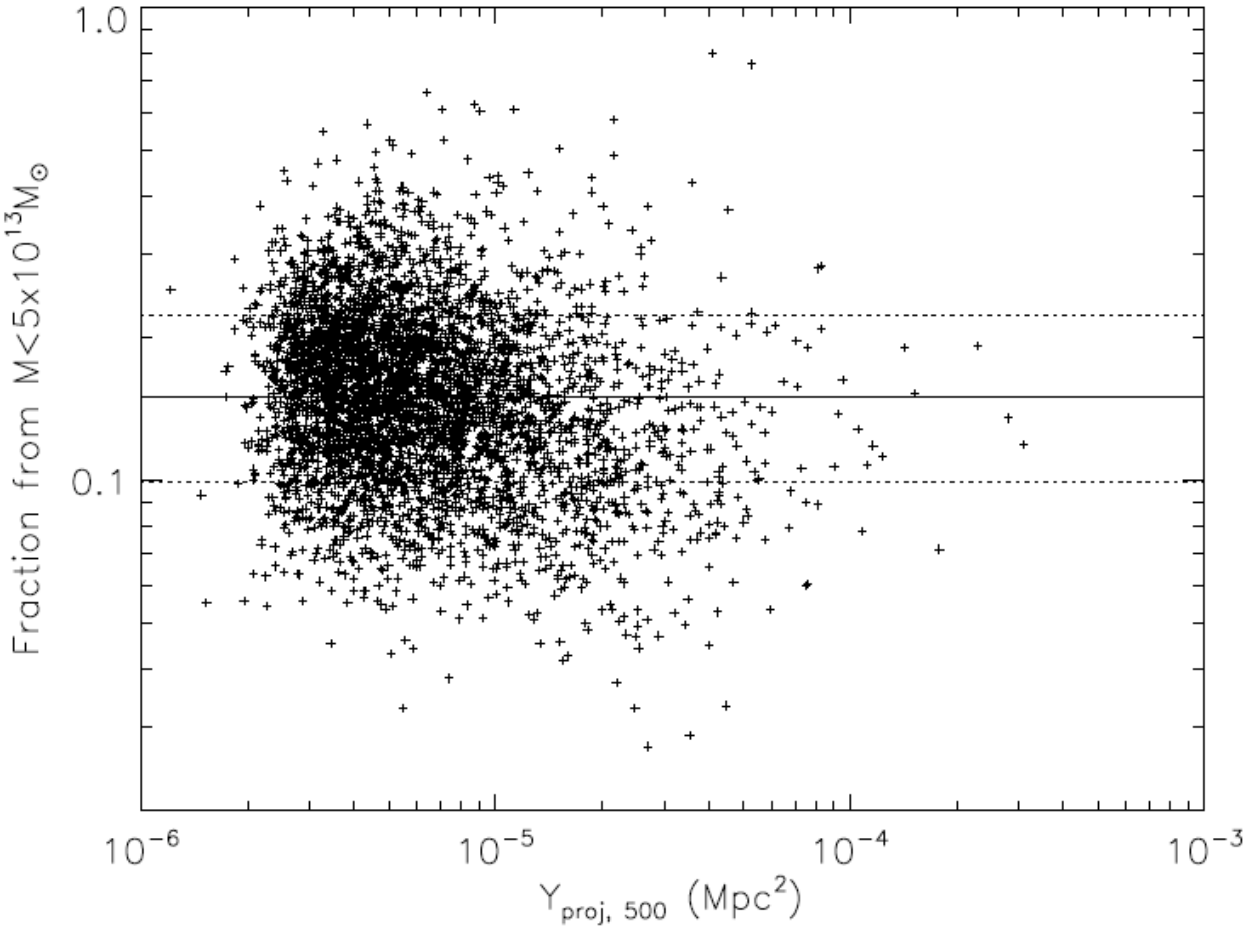
Integrated Y value for simulated clusters



Clusters as extracted from light cone



Mean contribution to cluster Y from groups/filaments



Conclusions

- Inclusion of hydrodynamics (and most likely other baryonic physics) critical for getting “right” answer in estimation of errors in SZ observations
- Some confusion is unavoidable, given SZ telescope beam sizes
- Non-negligible boost in signal from WHIM (filaments/groups), particularly at low halo galaxy cluster mass